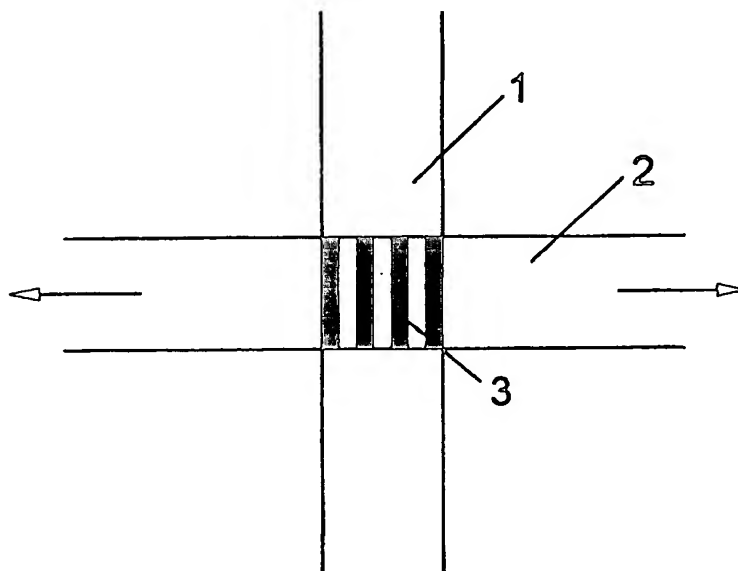




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : D04H 3/14, 3/04, B29D 28/00, B29C 65/14 // B29K 105:02	A1	(11) International Publication Number: WO 97/47796 (43) International Publication Date: 18 December 1997 (18.12.97)
(21) International Application Number: PCT/EP97/03057 (22) International Filing Date: 10 June 1997 (10.06.97) (30) Priority Data: 1003313 11 June 1996 (11.06.96) NL (71) Applicant (for all designated States except US): AKZO NOBEL N.V. [NL/NL]; Velperweg 76, NL-6824 BM Arnhem (NL). (72) Inventors; and (75) Inventors/Applicants (for US only): VAN VLIET, Arie, Hendrik, Frans [NL/NL]; Obrechtstraat 21, NL-6815 BN Arnhem (NL); PETERS, Sebastiaan, Martinus [NL/NL]; Klaroen 3, NL-6904 PB Zevenaar (NL). (74) Agent: SCHALKWIJK, Pieter, Cornelis; Akzo Nobel N.V., Patent Dept. (Dept. APTA), P.O. Box 9300, NL-6800 SB Arnhem (NL).		(81) Designated States: CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: GRID COMPRISING POLYMERIC DRAWN STRIPS AND A PROCESS FOR MAKING SAME

**(57) Abstract**

The invention pertains to a grid comprising drawn polymeric strips (1, 2) in at least two different directions, with the strips being bonded together in the zone or zones of overlap (3), wherein the said zone comprises at least two spatially separated bonding points or lines. The grids according to the invention exhibit improved strength and can be manufactured in a very efficient manner.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

GRID COMPRISING POLYMERIC, DRAWN STRIPS AND A PROCESS FOR MAKING SAME

5 The invention pertains to a grid comprising drawn polymeric strips in at least two different directions, with the strips being bonded together in the zone or zones of overlap.

10 Such a grid is known from WO 94/26503, which discloses a process for bonding drawn polymeric strips to form, *int. al.*, a grid. At and below the surface of at least one of the strips particles are provided which heat up in an electro-magnetic field having a frequency in the range of 10 to 50.000 MHz. Thus the strips are bonded together in the zone or zones of overlap by being exposed to the said field.

15 It was found, however, that when such a grid consisting of drawn polymeric strips is subjected to heavy loads, for instance when it is used as a so-called "geogrid" (i.e., a geofabric composed of a grate or grid of longitudinal and transverse strips which is used as soil consolidation in dike bodies, slopes, embankments, and the like), the loaded strips in the grid tend to
20 break more quickly at the bonds than might be expected on the basis of the strength of the strip itself and the bonding technique used.

It is an object of the present invention to avoid this phenomenon of early rupture. This object is achieved in the grid described in the opening
25 paragraph, wherein the said zone comprises at least two spatially separated bonding points or lines, preferably such that the bonding points or lines are separated by an imaginary and straight line running in between and parallel to the sides of one of the strips.

It was found that a single weld or bond covering the entire zone of overlap or most of the zone of overlap results in an unfavourable interaction between the longitudinal and the transverse strips which, in turn, results in the aforementioned early rupture of strips which are heavily loaded. This will now be elucidated with reference to a geogrid.

Use is made of a geogrid in which drawn polymeric strips (12 mm in width, always spaced 30 mm apart) are welded together across their entire contact area at an angle of about 90 degrees. Because the strips are drawn, the molecular chains are predominantly oriented in the longitudinal direction of the strip. As a result of this orientation the strips have a high tensile strength in the longitudinal direction and a low strain to failure in the transverse direction.

Forces exerted on the geogrid result in the strips being subjected to tensile load in both directions. On examination of one of the strips the following was found: under the influence of said tensile force there is a certain elongation of the strip. At the point where this strip and another strip in the transverse direction of the geogrid (from now on "transverse strip") are welded together across their entire contact area, this elongation generates a force transverse to the transverse strip. As was mentioned earlier, it is precisely in this direction that drawn strips have a lower strain to failure. Accordingly, heavier loads will cause the transverse strip to split.

In itself, such a split does not present a major problem to the geogrid. However, because the transverse strip and the loaded strip have been attached to each other across their entire contact surface, the split of the transverse strip will initiate a crack in the loaded strip. This crack in its turn gives rise to the early rupture of the loaded strip.

Separating the welds in the longitudinal direction of the loaded strip will mean, in the above-described situation, that the transverse strip will split between the welds. Once split, the transverse strip because of the separation of the welds is incapable of exerting any force on the loaded strip at the point of this split, and hence cannot cause early rupture of the loaded strip.

It is preferred that the zone of overlap comprises three or more spatially separated and parallel bonding lines. It has been found that, depending on the type of bonding used, the strength of grids which are loaded in a direction perpendicular to these lines can be virtually equal to the sum of the strips' strengths in that direction.

When the weld has separations in both directions of the geogrid, e.g., because there has only been spot welding near the angular points of the contact area, the above-described advantage applies in both directions of the geogrid. This can be of particular relevance in situations where the load to which the geogrid is subjected is likely to be about the same in both directions, or when it is not possible to accurately predict (the direction of) the load.

Preferably, the strips in the grid build an angle with each other ranging from 70 to 110, more preferably from 80 to 100 degrees, because such grids are comparatively strong and easy to manufacture.

25

Although the optimal width of the individual welds depends on the process conditions and the materials used and the person skilled in the art is capable of optimising this width without undue experimentation, it is generally preferred that the width of the bonding lines and the width or diameter of the bonding spots or points is 5 mm or less, more preferably 3

30

mm or less. When the bonding lines or points are too wide, the phenomenon described above may occur within the bonding point or line.

As will be explained in more detail below, a grid in which the bonding points or lines are welded by means of a laser is preferred for a number of reasons.

The invention also pertains to a process for manufacturing the above-described grid in which at least two strips are successively placed one on top of the other, pressed together, and heated by means of a radiation source emitting electromagnetic radiation, wherein the strip which faces the radiation source is transparent to the radiation, while (at least) at the points where the strips are bonded together the material absorbs said radiation.

It was found that by using this technique a very strong weld can be produced quickly (within milliseconds) and economically, and allows great freedom in designing the configuration of the weld, all without influencing the oriented structure of the polymer of which the strips are made (due to very local heating).

20

The energy supplied to the surface to be bonded preferably is in the range of 20 to 150 kJ/m². Greater preference is given to quantities in the range of 40 to 110 kJ/m² or even 60 to 90 kJ/m². The surface to be bonded preferably is not exposed to the radiation for more than 75 milliseconds or less than 5 milliseconds. When these quantities of energy and the exposure times of the process according to the invention are used, the orientation of the molecular chains suffers minimal disturbance (and, hence, minimal loss of strength) and a bond having very good strength is achieved.

30

Suitable polymers include thermoplastic polymers such as polyesters, polyamides, and polyolefins. In addition, said radiation may be absorbed either by the polymer itself or by a pigment added to the polymer.

- 5 In a very simple embodiment the strip facing the radiation source is made up wholly of transparent material. In that case there are several options. For instance, the strip facing away from the radiation source may be made of an absorbent material. Alternatively, the strips to be bonded can both be transparent, with a (thin) layer, such as a film or foil, of an absorbent
10 material sandwiched between the strips.

It will be evident that, in principle, any configuration can be used as long as there is a material which absorbs the radiation at the point where the bond is to be made and as long as the radiation can reach this material.

15

- Another suitable embodiment is the one in which the strip facing the radiation source is composed of more than one component. For instance, use may be made of a bicomponent strip (width 12 mm; thickness 0.55 mm) of transparent polyester (0.50 mm thick) and polyester to which a
20 pigment has been added (0.02 mm). This strip can be bonded to itself or to another strip in a number of ways, as long as the radiation is able to reach an absorbent section via a transparent section.

- One advantage of the use of the multi-component strip is that it can serve
25 both as an exposed and as an unexposed strip. Hence there is no need during production to have two or more supply lines for two or more different materials.

- Both the absorbing part of the strip comprising two or more components
30 and the mentioned intermediate layer (foil or film) may have a very small

thickness. Preferably, this thickness is in the range of 5 to 100 μm . However, in the selection of this thickness there will have to be taken into account, among others, the degree to which the material absorbs the radiation. In consequence, there is no absolute upper or lower limit.

5

Preferably, use is made of radiation with a wavelength in the range of 600 to 1600 nm. A large number of often inexpensive and reliable radiation sources is available for this range. Also, there are many pigments on the market which have high absorption in this range, e.g., carbon black.

10

Lasers are highly suitable for use in the process according to the invention. Unlike in the case of quartz lamps, the radiation emitted by lasers can be focused using comparatively simple means. Moreover, lasers have a narrow spectrum ("wavelength window"), which means that absorption by the transparent polymer can be avoided entirely or almost entirely. Lamps, on the other hand, have a comparatively wide spectrum, so that the emitted radiation will always comprise wavelengths which are absorbed by the transparent polymer. In many cases this not very desired absorption will be as much as about 35% of the total radiation energy. In the case of the invention it holds that this absorption preferably does not exceed 15%.

20

When the power density can be varied, a lower strength can be selected for the part of the weld at the edge of the zone of overlap than for the part of the weld at and near the centre of the zone of overlap. In this way objectionable marginal phenomena which are known to have a negative effect on the entire weld can be suppressed or eliminated.

25

The invention will be illustrated by way of an unlimitative example.

Fig. 1 shows two strips joined by means of a weld in accordance with the present invention.

Fig. 2 shows, as a comparative example, two strips joined by a weld
5 covering the entire zone of overlap.

Examples

10 Welding is carried out with a solid state or diode laser (OPC-A020-MMM-CS) emitting light at a wavelength of 820 nm. The laser beam is transformed into a line shape having a width of 0.3 mm (Full Width Half Maximum of a Lorentzian intensity distribution) and a length of 6 mm (uniform "top hat" intensity distribution).

15

A transparent strip (numeral 1 in Fig. 1 and having a strength of 560 MPa and a cross-section of $12 \times 0.55 \text{ mm}^2$) of polyethylene terephthalate (PET) and a black strip (2) of the same type with carbon black added to the PET were placed one across the other at an angle of 90° and pressed together
20 using a pressure of 1 megaPascal.

25

The line shaped beam is scanned across the zone of overlap of the strips at a speed of 2.25 centimeters per second. The laser beam was interrupted using 20 ms intervals, resulting in the bonding lines (3) being spaced 0.45
mm apart.

The procedure was repeated, but this time the weld (4) extended over the entire zone of overlap.

The welding experiments showed that, when cracks developed in the transparent transverse strip (1) during mechanical loading of the longitudinal black strip (numeral 2 in both Figures), the conventional weld (Fig. 2) suffered a large (~15%) decrease in strength retention of the longitudinal black strip (2), whereas the weld according to the present invention (Fig. 1) suffered no such decrease inspite of the occurrence of cracks.

Claims

1. A grid comprising drawn polymeric strips in at least two different directions, with the strips being bonded together in the zone or zones of overlap, characterised in that the said zone comprises at least two spatially separated bonding points or lines.

2. A grid according to claim 1, characterised in that the said zone comprises three or more spatially separated and parallel bonding lines.

3. A grid according to claim 1, characterised in that the said zone at least comprises one bonding point or line at or near each of the angular points of the zone of overlap.

4. A grid according to any one of the preceding claims, characterised in that the width of the points or lines is 5 mm or less or, preferably, 3 mm or less.

5. A grid according to any one of the preceding claims, characterised in that the bonding points or lines are welded by means of a laser.

6. A grid according to any one of the preceding claims, characterised in that the strength of the part of each bonding point or line at the edge of the zone of overlap is lower than the strength of the part of each bonding point or line at and near the centre of the zone of overlap.

7. A process for manufacturing the grid according to any one of the preceding claims wherein at least two strips are successively placed one on top of the other, pressed together, and heated by means of a radiation source emitting electromagnetic radiation, wherein the strip which faces the

radiation source is transparent to the radiation, while at the points where the strips are bonded together the material absorbs said radiation.

8. A process according to claim 7, characterised in that the strip facing the
5 radiation source is made entirely of transparent material.

9. A process according to claim 7, characterised in that the strip facing the radiation source comprises at least two different materials.

10 10. A process according to any one of the claims 7-9, characterised in that the radiation source used is a laser.

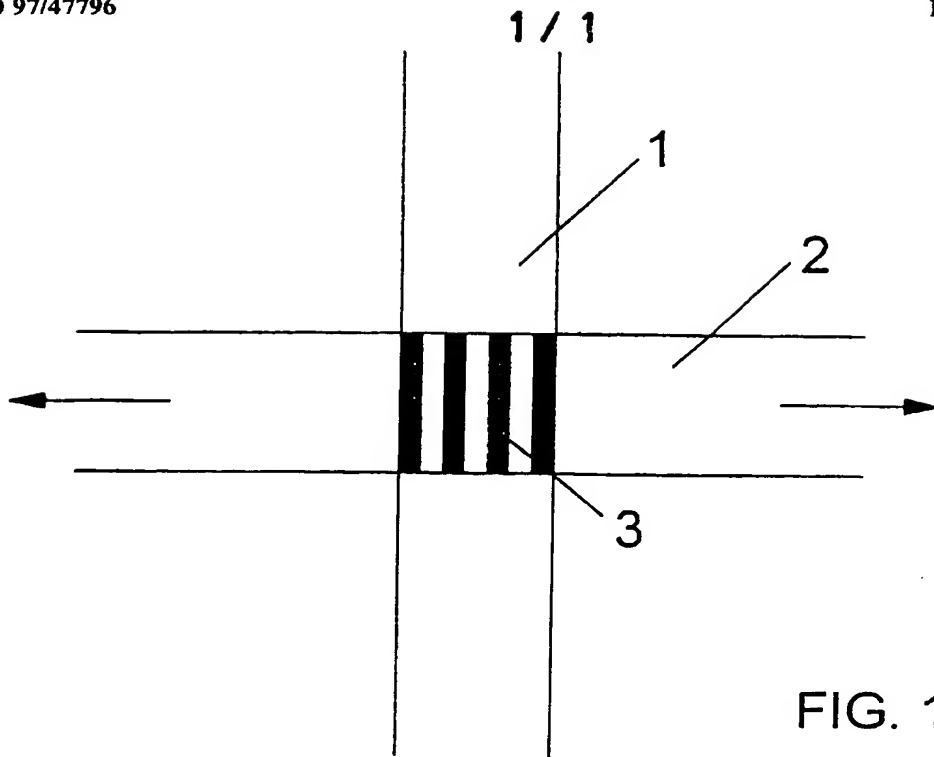


FIG. 1

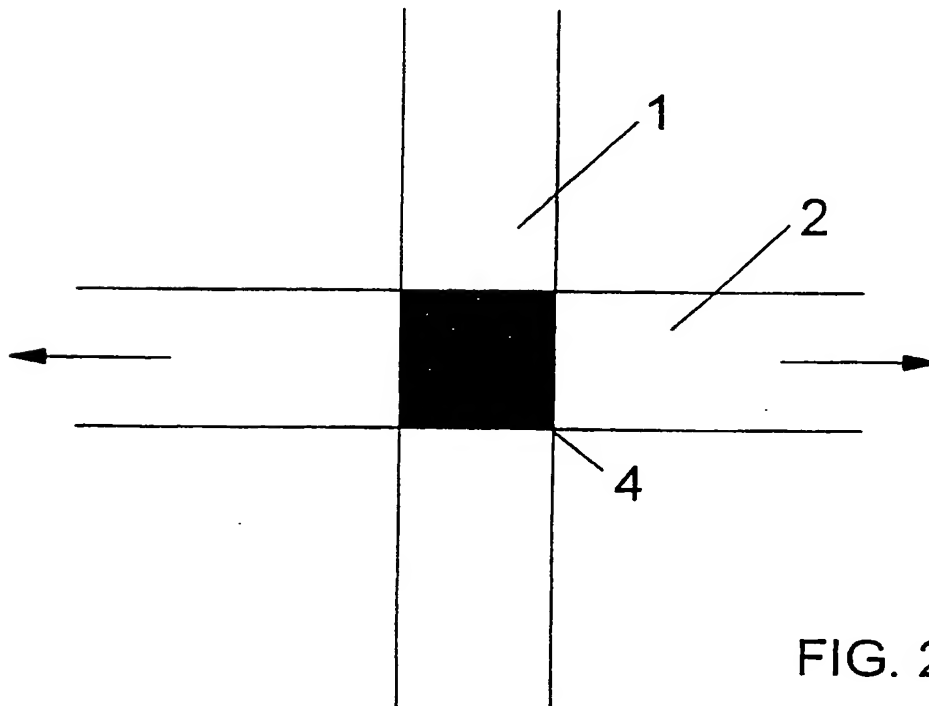


FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 97/03057

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D04H3/14 D04H3/04 B29D28/00 B29C65/14 //B29K105:02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D04H B29D B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 94 26503 A (AKZO NOVEL N V ;VLIET ARIE HENDRIK FRANS VAN (NL); HORIKX CORNELIS) 24 November 1994 cited in the application	1-5,8,10
X	see claims	7,9
Y	US 4 483 438 A (KOBIELLA ROBERT J) 20 November 1984 see column 2, line 22 - line 33; figures see column 2, line 51 - line 62; figure 2	1-4
Y	FR 1 506 163 A (FARBWERKE HOECHST AG, VORM. MEISTER LUCIUS & BRÜNING) 15 December 1967	5,10
A	see the whole document	7-9
Y	GB 1 101 762 A (MOBIL OIL) 31 January 1968	5,10
A	see claims 1,3,9,12-14,18	7-9
	--- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

8 October 1997

Date of mailing of the international search report

31. 10. 97

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Cordenier, J

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 97/03057

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 337 776 A (INTERLAKE INC) 18 October 1989	8
A	see column 4, line 21 - line 27	9
A	EP 0 564 189 A (SEKISUI JUSHI KK) 6 October 1993 see page 3, line 45 - line 55; figure 4 see page 5, line 17 - line 23 see page 5, line 53 - line 56	1,2
A	PATENT ABSTRACTS OF JAPAN vol. 004, no. 037 (M-004), 27 March 1980 & JP 55 009832 A (SEKISUI JUSHI CO LTD), 24 January 1980, see abstract	1,2
A	EP 0 416 497 A (LUECKE OTTO) 13 March 1991 see figures	1,2
A	GB 2 266 540 A (YANG JESSE) 3 November 1993 see claims	1-5,7-10
A	DE 22 46 051 A (NIPPON PETROCHEMICALS CO LTD) 5 April 1973	1
A	DE 41 37 310 A (AKZO NV) 19 May 1993 see claims	1
A	GB 2 103 147 A (PA MANAGEMENT CONSULT) 16 February 1983 see page 1, line 93 - line 99	8,9
A	GB 2 262 258 A (COOKSON GROUP PLC) 16 June 1993 see page 6, line 29 - line 35; claims; figure 2	1,4,7
A	DATABASE WPI Section PQ, Week 9349 Derwent Publications Ltd., London, GB; Class P13, AN 93-393503 XP002042846 & SU 1 757 528 A (MELNIKOV E L) , 30 August 1992 see abstract; figure 2	1-3
A	US 5 458 711 A (YANG JESSE) 17 October 1995 see abstract; claims 1,7	
A	US 3 316 687 A (D.S. BARTLETT) 2 May 1967 see column 2, line 26 - line 30	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 97/03057

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9426503 A	24-11-94	DE 4316015 A CA 2162686 A EP 0697953 A JP 8510180 T	17-11-94 24-11-94 28-02-96 29-10-96
US 4483438 A	20-11-84	AU 558824 B AU 2148783 A CA 1215312 A	12-02-87 24-05-84 16-12-86
FR 1506163 A	06-03-68	NONE	
GB 1101762 A		DE 1479686 A FR 1436130 A US 3560291 A	10-07-69 01-07-66 02-02-71
EP 0337776 A	18-10-89	US 4906320 A AT 108722 T AU 608149 B AU 3303289 A CA 1316224 A DE 68916833 D JP 2024116 A MX 170799 B US 4969969 A	06-03-90 15-08-94 21-03-91 19-10-89 13-04-93 25-08-94 26-01-90 15-09-93 13-11-90
EP 0564189 A	06-10-93	JP 7172405 A US 5542239 A	11-07-95 06-08-96
EP 0416497 A	13-03-91	DE 8910534 U	17-01-91
GB 2266540 A	03-11-93	NONE	
DE 2246051 A	05-04-73	AU 450207 B AU 4665372 A FR 2153403 A GB 1387701 A	04-07-74 21-03-74 04-05-73 19-03-75
DE 4137310 A	19-05-93	NONE	
GB 2103147 A	16-02-83	NONE	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 97/03057

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2262258 A	16-06-93	NONE	
US 5458711 A	17-10-95	NONE	
US 3316687 A	02-05-67	NONE	

